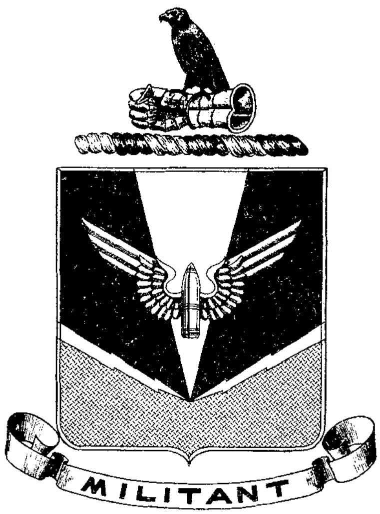
U.S. ARMY ST 44-188-2G

INTRODUCTION AND START-STOP TO THE AN/TPS-1G

(REVISED)



U.S. ARMY AIR DEFENSE SCHOOL

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CONTENTS

CHAPTER 1

INTRODUCTION

1. PURPOSE

This text is to provide technical information of the AN/TPS-1G radar.

2. SCOPE

This text covers the characteristics, employment, and block diagram functioning of the AN/TPS-1G. It also includes the start-stop procedure of the PU-107/U power unit and the AN/TPS-1G radar.

CHAPTER 2

INTRODUCTION TO THE AN/TPS-1G

Section I. INTRODUCTION

3. GENERAL

A defense acquisition radar is of prime importance in the present air defense system to enable detection of aircraft or missiles long before they come within the range of battery acquisition radars or the target-track radar. The preliminary operations performed by a missile unit to engage and kill a target require time. If the missile unit is alerted soon enough, the preliminary operations will be completed before the target comes within its range. It is the mission of the AN/TPS-1G defense acquisition radar to alert associated missile units on the approach of hostile air targets so they may engage targets at the maximum range of their missiles.

Section II. GENERAL INFORMATION

4. HISTORY

The nomenclature of AN/TPS-1G means Army-Navy transportable radar search, model number 1G. This radar is an improved version of the AN/TPS-1D. The improvements include a new antenna that provides much better vertical beam coverage, a gated MTI system that eliminates close-in fixed targets and ground clutter but still maintains receiver sensitivity at extreme ranges, and a larger plan position indicator (PPI) that provides better target discrimination. Other improvements will be discussed throughout this course. The AN/TPS-1G or its counterpart the AN/FPS-36, a modified AN/TPS-1D, is organic to all air defense battalions to provide information of hostile air activity.

5. PURPOSE

The AN/TPS-1G is a medium range (160 nautical miles or 184.25 statute miles) defense acquisition radar set that has the purpose of providing range and azimuth information to its associated Army air defense command post (AADCP).

Section III. EMPLOYMENT

6. GENERAL DESCRIPTION

The AN/TPS-1G consists of six basic units plus an antenna, as shown in figure 1. These six units are the modulator, range-azimuth indicator, power supply, receiver-transmitter, antenna base, and signal comparator. Each unit is approximately a 2-foot cube in volume and weighs about 300 pounds, making the total weight of the radar approximately 1,900 pounds, excluding the cabling. Because the radar can be divided into six units, it is easily transported and emplaced.

7. EXTERNAL POWER SOURCE

The primary power source for the radar is provided by a PU-107/U power unit. Two PU-107/U power generators should be requisitioned for each radar. One unit supplies enough power for operation of the set, and the other is a spare. The AN/TPS-1G requires 115-volt (±5 percent), 400-cycle (±4 percent), single-phase power for its operation. The radar circuits alone consume 5 kilowatts of power with an additional 2.5 kw for the heaters; therefore, the total power for the radar is 7.5 kw. The PU-107/U has a power output of 10 kw when connected for a single-phase output as required by the radar.

8. MOVEMENT

The radar and power unit are moved in two $2\frac{1}{2}$-ton trucks and one 1-ton or $1\frac{1}{2}$-ton trailer. The radar units are carried in the two trucks and the trailer is for the two PU-107/U generators. The individual radar units, because of size and weight, can be carried short distances by men, which allows transportation to sites inaccessible to vehicles.

9. EMPLACEMENT

a. Many methods of emplacement have been used, but the most common methods are the one-stack and three-stack arrays. In the one-stack array shown in figure 1, all six units are stacked in one tower. This array provides an overall height of $20\frac{1}{2}$ feet, which is desirable to provide good propagation of rf energy. However, difficulties in emplacing, maintaining, and servicing the upper units create obvious disadvantages.

b. The three- or multiple-stack array shown in figure 2 may also be used. The advantage to this type of emplacement is the ease of accessibility to all units for maintenance and servicing. It facilitates, as well, emplacement and march order. The slight decrease in antenna height, about four feet, does not affect the overall functioning and maximum range capabilities too greatly.

c. For the one-stack type of emplacement, a shelter, S-68/TPS-1D, is issued with the radar. For the three- or multiple-stack array, command post tent M1945 must be requisitioned.

d. At permanent site, the radar may be sheltered in a building or hutment. The units may be arranged in any manner as determined by the external cable lengths for connecting the units to the power supply.

10. THE AN/GSS-1

The electronic search central, AN/GSS-1 (fig 3), is a closed van that may be mounted on a $2\frac{1}{2}$-ton truck. The van has mountings for the AN/TPS-1G, an AN/TPX-19 IFF set, AN/GRC-9 and AN/GRR-5 radios, a plotting board, maintenance bench, and spare parts cabinets. The van can remain on its truck emplacement or be removed to a ground site, with the radar being operated from inside the van. Keeping the van on the truck makes the equipment highly mobile and most useful to battalions often changing position. In movement, a $2\frac{1}{2}$-ton truck is used for the antenna, which must be removed from the top of the van. The AN/GSS-1 is presently organic to Hawk battalions.

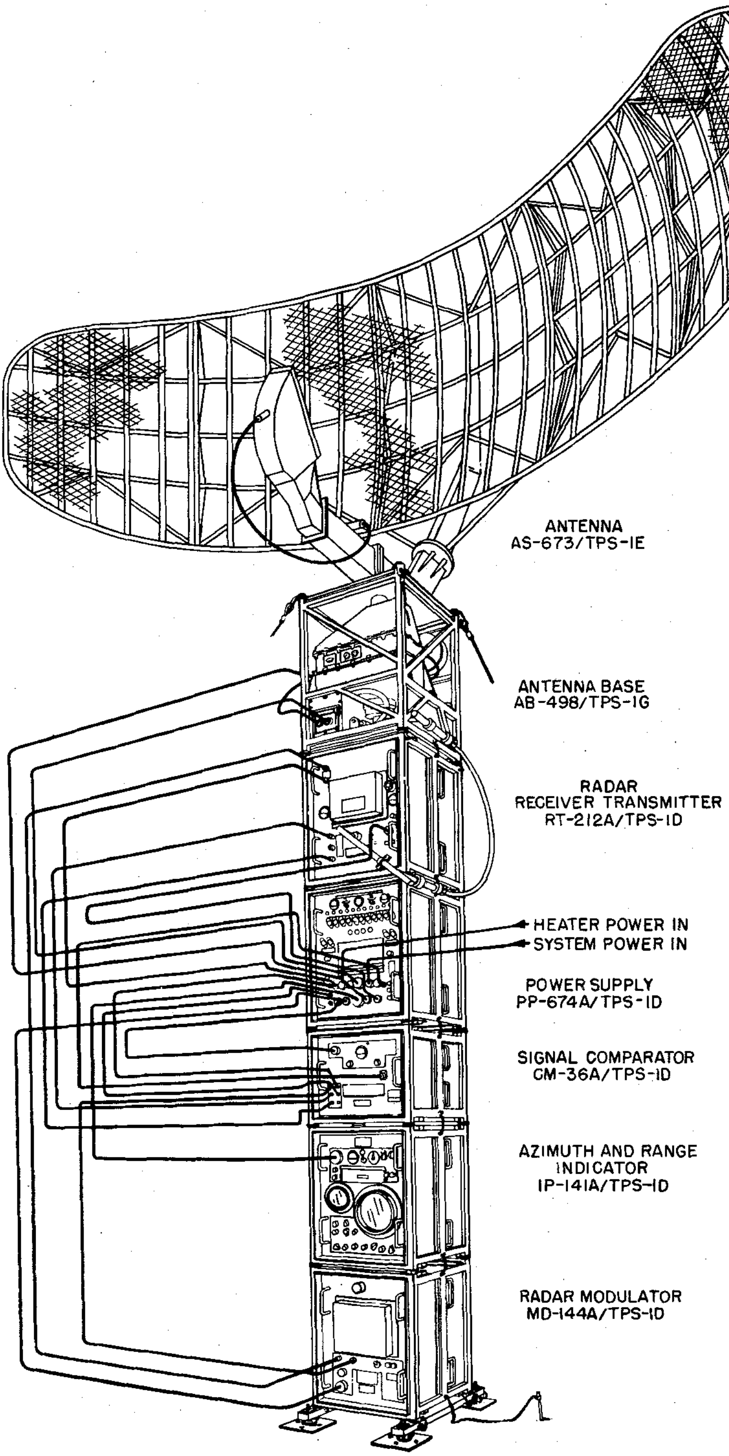


Figure 1. Radar set AN/TPS-1G (one-stack array).

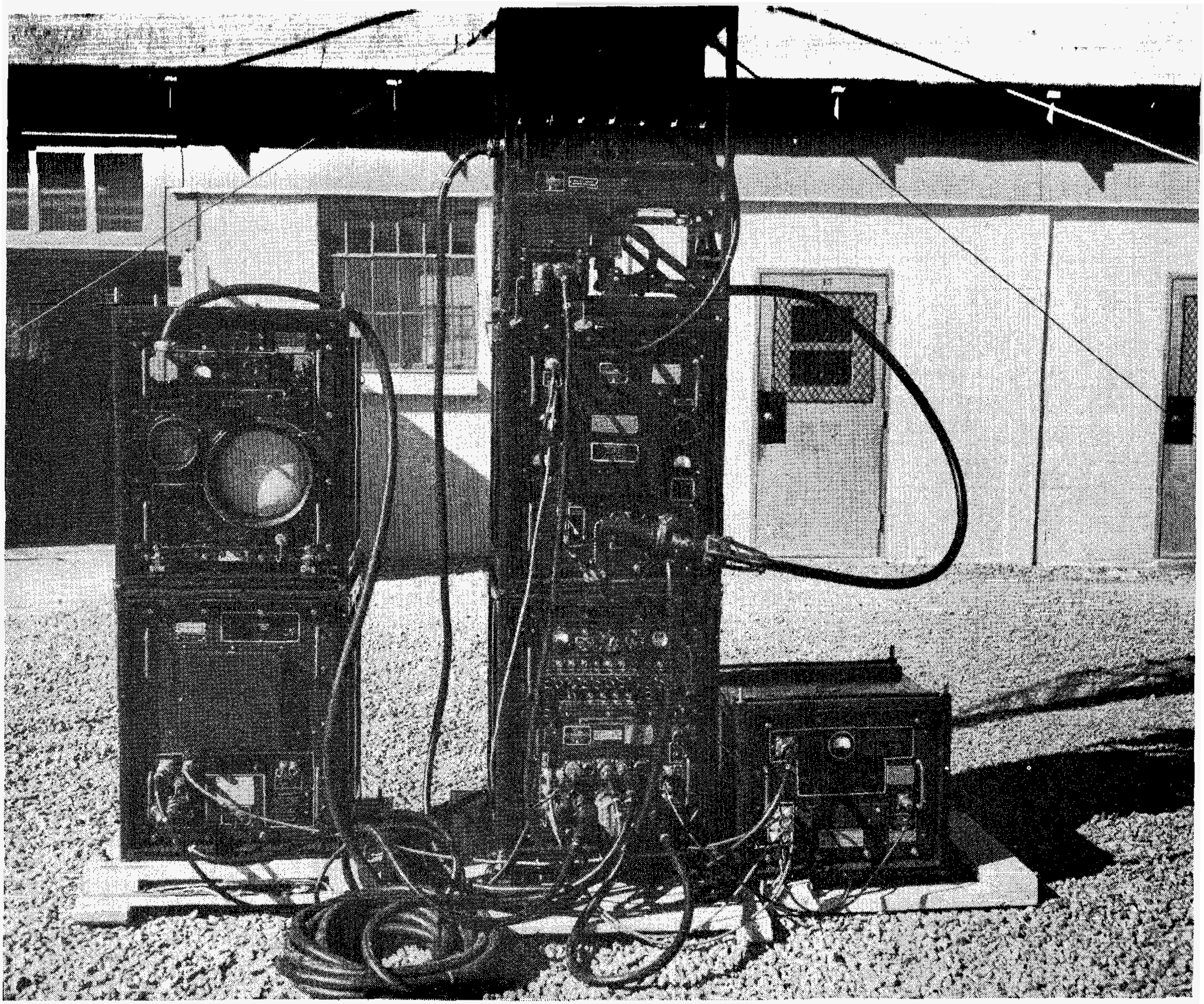


Figure 2. Three-stack array.

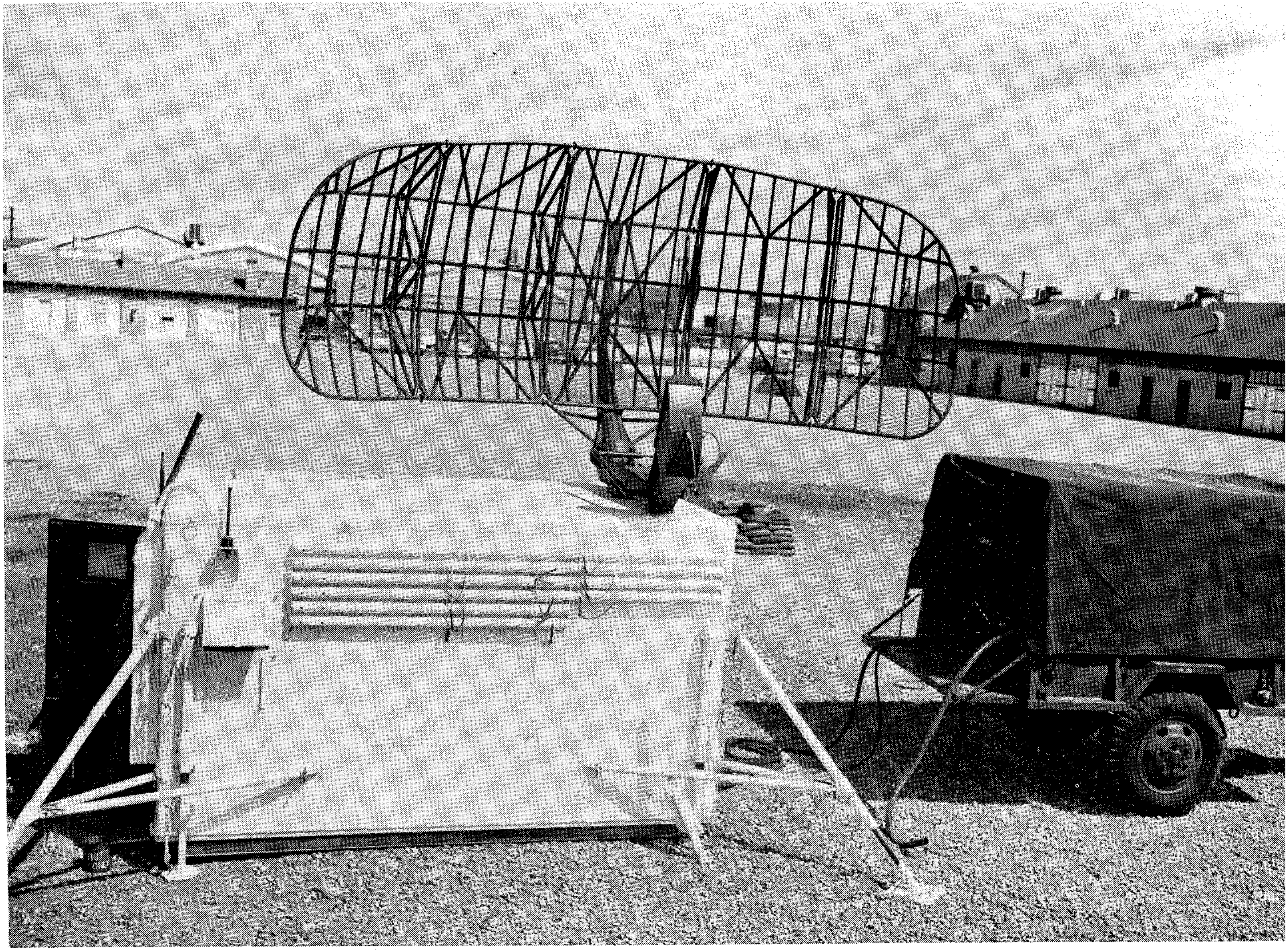


Figure 3. Electronic search central AN/GSS-1.

11. BASIS OF ISSUE

The radar is issued to all air defense battalions. However, in the United States Army Air Defense Command (US ARADCOM) the defense acquisition radar is the AN/FPS-36, which is basically the same as the AN/TPS-1D with certain modifications to increase its maximum range. Listed below are the radars or search centrals authorized.

*1 - AN/FPS-36 or AN/TPS-1G	Nike battalion in US ARADCOM
1 - AN/TPS-1G	Nike battalion in field army or overseas
1 - AN/GSS-1	Hawk and AW mobile battalions
1 - AN/TPS-1G and AN/GSS-1	Airborne AW battalion

*The AN/FPS-36 is basically the AN/TPS-1D with the 40 x 11 antenna and other modifications to increase maximum range to 200 nm. Some air defense regions in the continental United States have consolidated the AN/FPS-36's to form a provisional radar detachment consisting of several AN/FPS-36's and reporting targets to a regional air defense command post (ADCP).

Section IV. CHARACTERISTICS

12. DATA

a. From the operation of the radar, the two elements of data obtained are slant range and azimuth. There is no provision for height finding information, since the antenna is fixed in elevation. The slant range and azimuth data are transmitted by either radio or telephone communication to the using units, or by an electronic automatic data link.

b. Information data may be obtained for either moving targets alone or for fixed targets. In NORMAL operation, the presentation includes all targets. However, since moving target data are normally all that are desired, the radar has a gated moving target indicator (MTI) system. When gated MTI is used, ground clutter and fixed target echoes can be canceled by the MTI circuits up to the ranges desired by the operator.

c. The data charcteristics of the radar are listed below.

Maximum range:	160 nautical miles.
Range accuracy:	Within 3 percent of the range to the target plus 1 mile.
Azimuth:	6,400 mils, by electrically controlled rotation of the antenna up to 15 rpm, CW or CCW.
Azimuth accuracy:	±1%.
Elevation resolution:	None.
Operation:	Gated MTI or normal.

13. MODULATOR

The modulator develops the timing and power triggers used to pulse the transmitter. The timing trigger is generated in either the modulator or signal comparator unit. An external trigger, obtained from the signal comparator, is at a precision rate of 400 pulses per second and is gated for MTI operation. A variable prf of 360 to 400 pps is possible by using the internal trigger, which is formed in the modulator and can be used only in NORMAL operation.

14. TRANSMITTER

The transmitter components are housed in the receiver-transmitter unit and produce the rf energy from the timing and power pulses from the modulator. The output and generating components are:

Frequency:	1,220 mc to 1,350 mc (L-band).
Wavelength:	24.6 cm to 22.2 cm.
Peak power:	500 kw.
Pulse width:	2 microseconds.
Transmitter oscillator:	5J26 magnetron.

15. RECEIVER

The receiver accepts from the antenna the reflections from targets, and changes the rf energy into an intermediate frequency for amplification. After amplification, the signals are detected for video and applied to presentation screens at the indicator. The receiver frequencies are:

Received frequency:	1,220 mc to 1,350 mc.
Local oscillator frequency:	1,280 mc to 1,410 mc.
Intermediate frequency:	60 mc.
IF bandwidth:	1.1 mc over 4 mc bandspread.
Local oscillator:	2C40 lighthouse tube.

16. SIGNAL COMPARATOR

The signal comparator contains the moving target indicator circuits, the 60-mc intermediate frequency amplifier, one crystal for amplitude detection, and two additional crystals for phase detection. Amplitude detection is used for normal operation, and phase detection is used for MTI operation.

17. INDICATOR

The indicator provides a means to view the received echoes on two presentation screens, the A-scope and PPI. The screens have different sweep ranges and are independent of each other. The presentation scopes and sweep ranges are:

Screens: 10-inch PPI; 5-inch range scope (A-scope).

PPI sweep ranges: 20, 40, 80, and 160 nautical miles.

Range (A-) scope sweep ranges: 20, 40, 80, and 160 nautical miles.

Expand sweep: Any 10-mile interval of range from 10 to 160 nautical miles, depending upon the range strobe setting.

Range markers: 5-mile markers for 20 and 40 mile sweeps; 25-mile markers for the 80 and 160 mile sweeps.

Range strobe marker: A marker that is visible on the PPI sweep can be gated from 10 to 160 nautical miles and initiates the expand sweep on the A-scope.

15. ANTENNA AND ANTENNA BASE

The antenna base controls the drive assembly for the azimuth rotation of the AS-673/TPS-1E antenna. The antenna is approximately 6.2 feet in height and 15.7 feet in width (figure 4) and can be disassembled into five sections for movement.

Type of antenna: Cosecant-squared.

Antenna pattern: Cosecant-squared radiation pattern.

Beamwidth: 3.4° to .4° horizontal; 10° to 12° vertical, cosecant-squared from +9° to 42°.

Antenna rotation speed: Up to 15 rpm, CW or CCW.

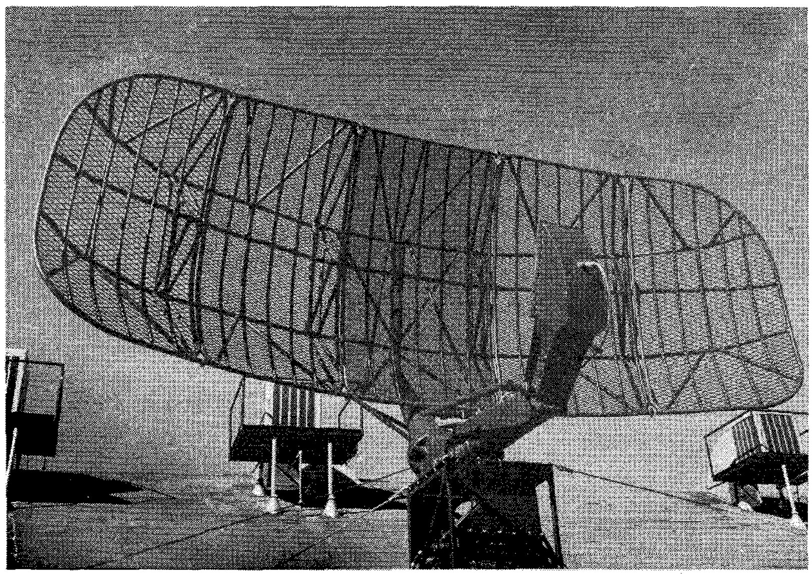


Figure 4. Antenna AS-673/TPS-1E.

19. POWER SUPPLY

The power supply accepts the alternating current from the PU-107/U and rectifies it into the necessary direct current potentials for the units of the radar. Separate inputs are used for the radar and heater supplies. The unit also acts as a signal junction box between the other units of the set. The input and output potentials of the power supply are:

Input: 115 volts (±5 percent), 400 cycles (±4 percent) single phase.

Power required: 5 kw for radar operation and an additional 2.5 kw for heaters.

Power source: PU-107/U generator.

Direct-current outputs: +450, +300 volts; +150, -150 volts; +27 volts.

Section V. BLOCK DIAGRAM DISCUSSION

20. GENERAL

Four of the six units directly develop the transmitted energy and receive, detect, and present the reflected energy. These units are the modulator, receiver-transmitter, signal comparator (MTI), and azimuth-range indicator (fig 5). The antenna base contains the rf plumbing and the antenna drive system. The antenna drive system electrically controls the speed and direction of rotation of the antenna. The power supply serves to supply all other circuits with the necessary dc voltages.

21. MODULATOR

a. Purpose. The modulator develops and shapes the pulse used to fire the transmitter at the proper repetition frequency.

b. Functioning. The modulator has two methods of operation; internal and external. In internal operation, the modulator generates its own trigger by a variable-frequency (360 to 400 pps), free-running multivibrator. In external operation, it receives a precision frequency trigger of 400 pps from the signal comparator. The external trigger is normally used in normal operation and is a necessity for proper MTI operation. The trigger pulse is shaped and used to fire the hydrogen-thyratron modulator switch tube. The firing of this tube allows an LC pulse-forming network, which is charged to twice the value of its applied voltage, to discharge through the primary of the transmitter pulse transformer. The pulse-forming network determines the pulse width of the transmitted energy.

c. Output. The output of the modulator is a -5,000-volt, 2-microsecond pulse. The prf resulting from the external trigger is 400 pps, and the variable internal trigger is from 360 to 400 pps.

22. TRANSMITTER

a. Purpose. The transmitter generates short pulses of rf energy for radiation into space

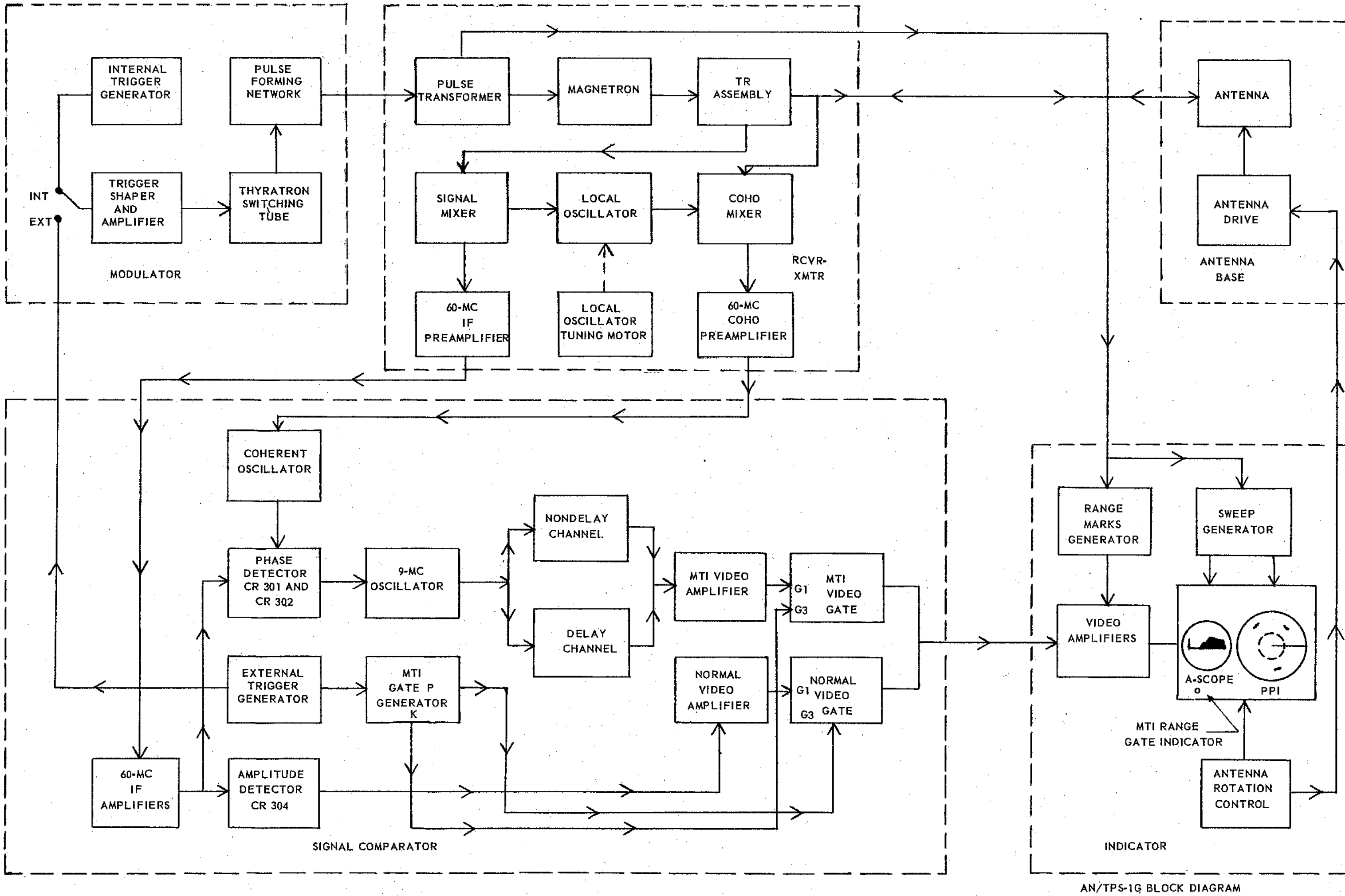


Figure 5. Block diagram of AN/TPS-1G.

b. Description. The transmitter consists of a pulse transformer, which steps up the modulator output pulse, and a type 5J26 magnetron oscillator, which is frequency tunable from 1,220 mc to 1,350 mc.

c. Functioning. The 2-microsecond, -5,000-volt pulse from the modulator is stepped up to -27,000 volts by the pulse transformer and is applied to the cathode of the magnetron oscillator. The negative pulse causes the magnetron to oscillate for the 2-microsecond duration of the pulse. The output of the magnetron is coupled to a coaxial-line rf system, which conducts the transmitted energy to the antenna.

d. Output. The output of the transmitter consists of 2-microsecond pulses of rf energy at a repetition frequency that is variable from 360 to 400 pps. The peak power output is 500 kilowatts, and the radio frequency of the transmitted pulse is tunable from 1,220 mc to 1,350 mc.

23. RECEIVER

a. Purpose. The receiver detects rf energy reflected from targets and converts that rf energy into if signals which can be amplified and used.

b. Description. The receiver consists of a TR assembly, a signal mixer, a local oscillator, if preamplifiers, and a coherent mixer and preamplifier.

c. Functioning.

(1) RF energy reflected from targets is picked up by the antenna and conducted through the TR assembly and harmonic filter to the signal mixer, where it is mixed with the local oscillator output to produce a 60-mc if signal. The TR assembly and harmonic filter protect the crystal in the signal mixer from being damaged by the high-power rf energy that is present when the transmitter is fired. The 60-mc output of the signal mixer is applied through a preamplifier to the if amplifier and detector circuits in the signal comparator unit.

(2) The local oscillator is a 2C40 lighthouse tube and may be tuned from 1,280 mc to 1,410 mc. The local oscillator is tuned 60 mc above the transmitted frequency. The lighthouse tube is tuned manually by varying the electrical length of the plate coaxial line. A small amount of transmitted energy is coupled into the coho mixer where it is mixed with the output of the local oscillator. The resulting 60-mc synchronizing signal is applied to the coherent preamplifier for amplification.

d. Output. The output of the receiver consists of 60-mc if signals, which are applied to amplifier and detector circuits in the signal comparator unit. The 60-mc sync signal from the coho preamplifier is applied to the coherent oscillator in the signal comparator.

24. SIGNAL COMPARATOR (MTI)

a. Purpose. The purpose of the moving target indicator is to eliminate echoes from ground clutter and close-in stationary targets.

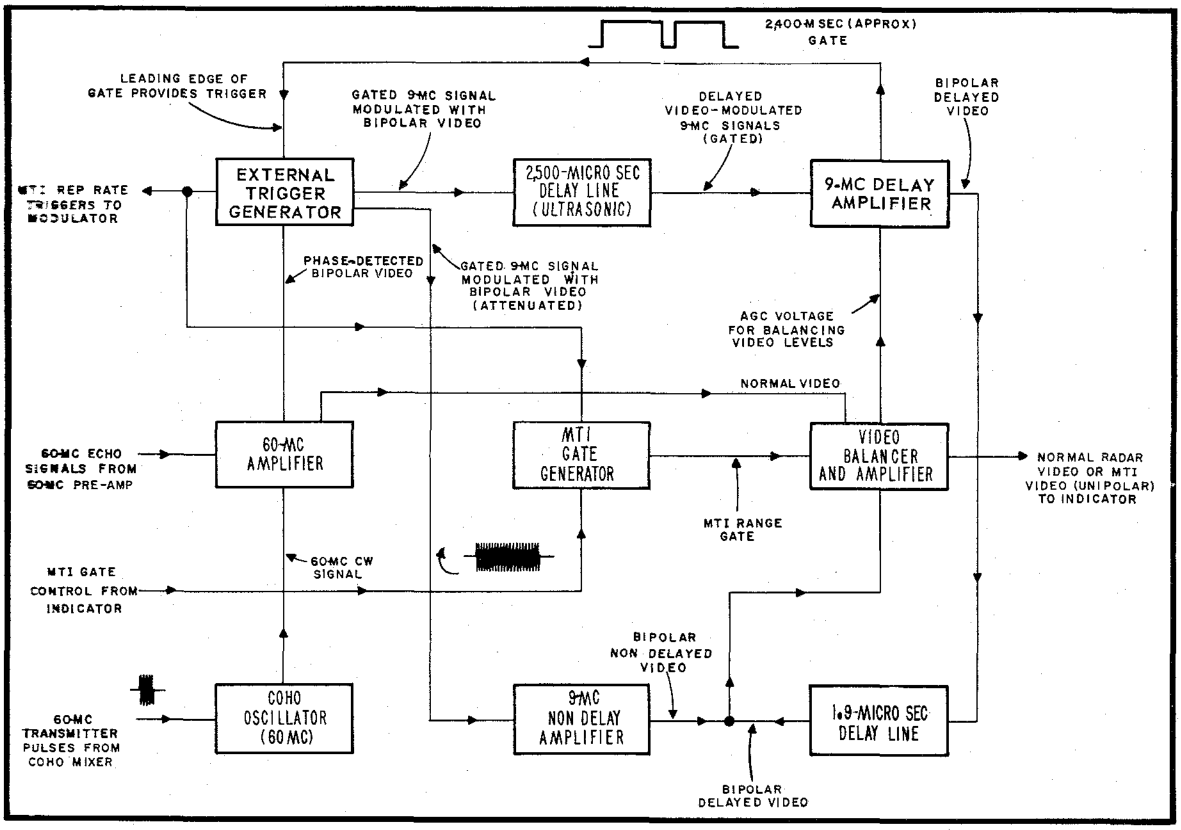


Figure 6. Signal comparator block diagram.

b. Description. The signal comparator (fig 6) consists of the 60-mc if amplifier channel, coherent oscillator synchronizing channel, amplitude detector, phase detector, MTI gate generator, 9-mc delay channel, 9-mc nondelay channel video detectors and amplifiers, and the external trigger generator.

c. Functioning.

(1) In normal operation, the 60-mc if signals from the receiver are amplified and applied to the amplitude detector. The output of the detector is negative video pulses, which are amplified, inverted, and applied to the range-azimuth indicator.

(2) In MTI operation, signals from the 60-mc if amplifier and the coherent oscillator are applied to a phase detector and then to the MTI gate generator. The duration of the output of the MTI gate generator is determined by the setting of the MTI range gate indicator potentiometer located on the front of the indicator. This potentiometer may be set to provide MTI operation from 0 to 160 nautical miles.

(3) Within the signal comparator unit are circuits that generate gating pulses for keying the normal and MTI video (in their correct sequence), thus providing gated MTI

operation. The gate pulses are generated by a phantastron circuit. During the normal condition, the output of the gate generator is enabling the normal video circuits in the video amplifier and disabling the MTI circuits. When a negative trigger pulse is applied to the phantastron from the external trigger generator, a switching action occurs, resulting in the generation of a pulse that then enables the MTI circuits and disables the normal video circuits. The duration of this pulse determines the point (in time and consequently in range) at which the system switches from MTI back to normal operation.

(4) Because the time between successive transmitted pulses must remain exactly the same for proper MTI operation, the precision-timed trigger is developed in the MTI unit and applied to the modulator. This external trigger has a pulse repetition frequency of 400 pps and a period of 2,500 microseconds.

d. Outputs. The output of the signal comparator in normal operation will be positive video for both fixed and moving targets. In MTI operation, the output will be positive video for moving targets only for the duration of the MTI gate and positive video for both fixed and moving targets for ranges beyond the MTI gate.

25. RANGE-AZIMUTH INDICATOR UNIT

a. Purpose. The range-azimuth indicator gives a visual representation of all reflecting objects in the path of the rf energy radiated from the radar antenna and provides a means of determining the range and azimuth of those objects.

b. Description. The range azimuth indicator system consists of the range scope (A-scope) and the PPI with their associated sweep circuits, range-marker generators, and video amplifier stages.

c. Functioning. A positive trigger pulse from the pulse transformer initiates the action in the sweep generators for the range scope and PPI. The length of the sweeps can be changed by separate range selector switches for both the range scope and PPI so that the sweeps represent 20, 40, 80, or 160 nautical miles of range. In the range scope, there is also an expanded sweep which represents any 10 miles of range from 10 to 160 miles. The starting point of this expanded sweep is determined by the position of the strobe marker, which is a movable dot on the PPI sweep. The trigger from the pulse transformer also initiates action in the range marker generator circuits so that 5-mile markers are provided on the 20- and 40-mile sweep ranges, and 25-mile markers are provided on the 80- and 160-mile sweep ranges. Radar video and range marker signals are applied to the video mixer stages of each scope. In addition, IFF video signals and the range strobe marker are applied to the PPI video mixer so that these signals can be displayed on the PPI.

26. ANTENNA DRIVE SYSTEM

a. Purpose. The antenna drive system rotates the antenna at a constant speed for any particular setting of the ANTENNA ROTATE control. The ANTENNA ROTATE control will vary the speed of rotation in either direction up to 15 rpm.

b. Functioning. The antenna drive system electrically controls the speed and direction of the antenna. The antenna base employs spur gearing, and it operates with dry-type lubrication. It includes a solenoid-controlled brake that is applied whenever power is removed from the drive-motor field.

Section VI. ANTENNA BEAM PATTERN

27. CHARACTERISTICS

a. The antenna unit supplied with AN/TPS-1G has a radiation pattern that is approximately cosecant-squared for both radar and IFF. The antenna pattern consists of a 3.4° to 4° horizontal beam width and a vertical radiation pattern of 10° to 12°, cosecant-squared from +9° to 42° (fig 7).

b. The reflector is 15.7 feet wide and 6.2 feet high, which represents an increase in reflecting surface of approximately 50 percent over that of the AN/TPS-1D antenna. The cosecant-squared radiation pattern provides excellent close-in overhead coverage. The antenna-base unit of AN/TPS-1G is designed to supply the driving power required for stable operation in high winds.

Section VII. SUMMARY AND QUESTIONS

28. SUMMARY

a. The defense acquisition radar, AN/TPS-1G, provides warning of hostile air actions long before the air vehicles come within range of Nike and Hawk air defense missile battalions. It provides slant range and azimuth information to the AADCP. The set, composed of six units plus antenna, is easily moved, emplaced, and march-ordered, especially when installed in the electronic search central, AN/GSS-1.

b. The operating characteristics of the radar are:

Maximum range:	160 nautical miles.
Azimuth search:	6,400 mils.
PRF (Internal):	360 to 400 pps.
(External):	400 pps.
Transmitter frequency:	1,220 mc to 1,350 mc.
Peak power:	500 kw.
Intermediate frequency:	60 mc.
Range presentations:	20, 40, 80, and 160 nautical miles, 10 miles on the A-scope in EXPAND.
Antenna speed:	Up to 15 rpm (CW or CCW).
Power requirements (radar):	115 volts, 400 cycles, single-phase, 5 kw.
(heaters):	115 volts, 400 cycles, single-phase, 2.5 kw.

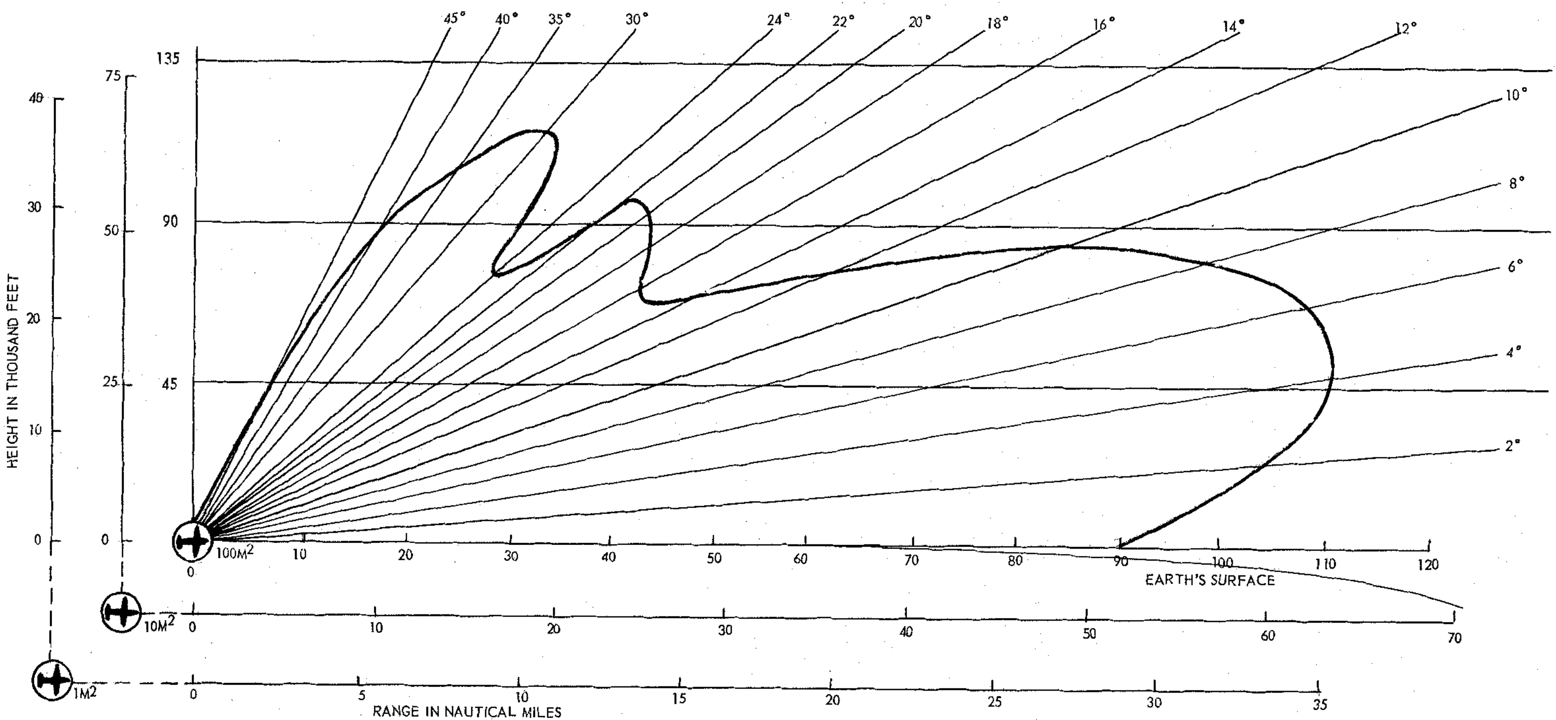


Figure 7. Cosecant-squared vertical radiation pattern.

Two types of operation: Normal or gated MTI.

c. The block diagram operation of the AN/TPS-1G units is listed below:

(1) The modulator shapes and amplifies the 2-microsecond pulse used to fire the transmitter. A variable-frequency (360- to 400-pps) internal trigger pulse is developed in the modulator, or the modulator may be triggered by a 400-pps external pulse from the signal comparator unit.

(2) The transmitter generates pulses of rf energy, tunable from 1,220 mc to 1,350 mc. Peak power output is 500 kw.

(3) The receiver produces 60-mc if signals from the reflected rf energy.

(4) The signal comparator unit (moving-target indicator) eliminates echoes from stationary targets when gated in MTI operation.

(5) The range-azimuth indicator unit develops the sweeps and range markers for the range scope and PPI and mixes the video signals in the proper manner for presentation on the two screens.

(6) The antenna drive unit system rotates the antenna at a constant speed. The speed of rotation can be varied in either direction up to 15 rpm.

29. QUESTIONS

a. What is the primary mission of the AN/TPS-1G?

b. What are the elements of data obtained?

c. How are the data transferred from the radar to the using units?

d. What is the maximum range in nautical miles?

e. List the issue of the radar for air defense battalions.

f. What is the AN/GSS-1? What equipment can it accommodate? To what units is it issued?

g. What are the limits of the two prf's? When must the EXTERNAL timing trigger be used?

h. What is the range of the transmitter frequency?

i. What is the transmitter peak power?

j. What are the sweep ranges on the PPI? The A-scope?

k. What does gated MTI operation achieve?

l. What is the external power source?

m. What are the power requirements of the radar?

n. What is the antenna beam coverage, horizontally and vertically?

o. Is the vertical beam a solid coverage?

CHAPTER 3

START-STOP OF THE AN/TPS-1G

Section I. INTRODUCTION

30. PURPOSE

The operation of the AN/TPS-1G demands that a thorough understanding of the start-stop and operator adjustments be acquired by maintenance men and operators. The steps outlined in this text must be followed in preparing the radar for operation; however, this outline does not include field adjustments or performance checks, which would not be attempted by operators. The start-stop procedure includes the PU-107/U and the AN/TPS-1G.

Section II. PRELIMINARY INFORMATION

31. GENERAL

There may be known malfunctions in either the radar or power unit that can be removed during the shutdown period. Also, troubles may arise during the starting procedure. In either condition, corrections must be made by maintenance men before continuing the starting of the radar.

32. OVERALL STARTING STEPS

The starting procedure may be divided into four steps, each being divided into smaller steps or checks. The four main steps are:

a. Obtaining the power from an external source, the PU-107/U.

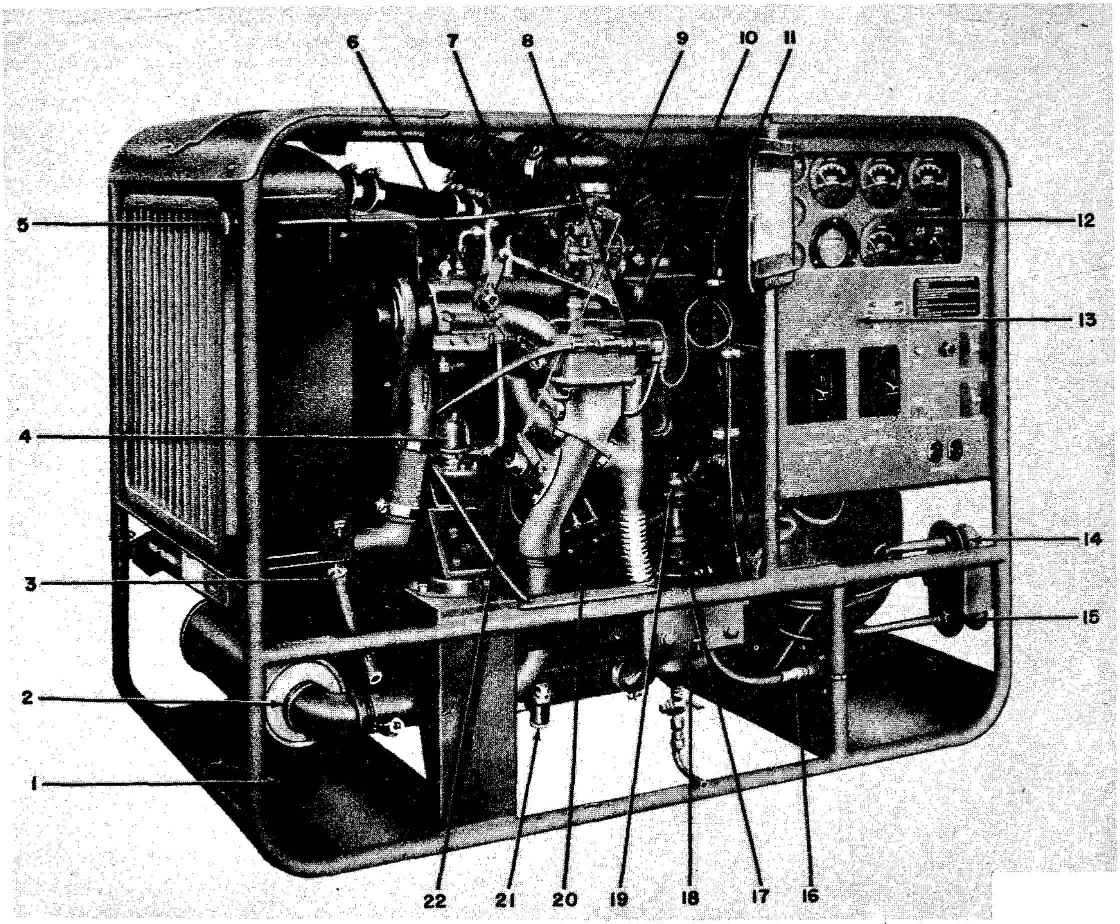
b. Starting the AN/TPS-1G.

c. Wait for the 5-minute delay to elapse and make the necessary preoperational checks during this period.

d. Fully energize the radar, including the operation of the antenna and transmitter system.

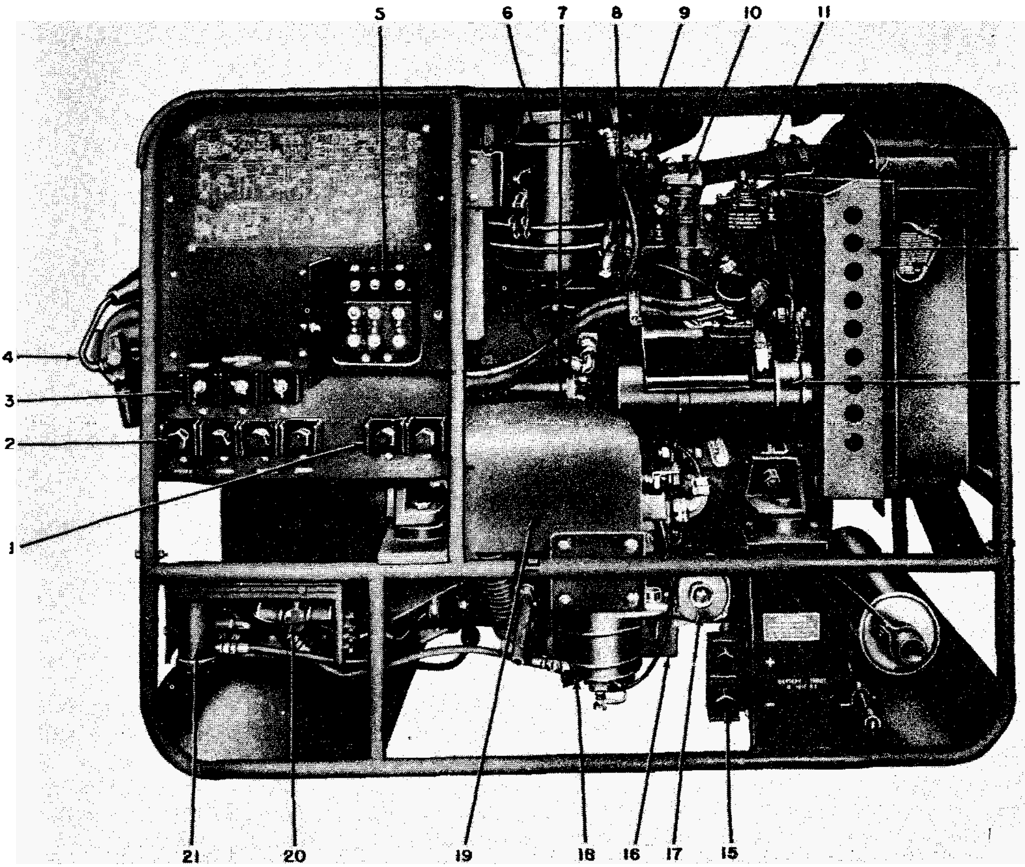
33. CHARACTERISTICS OF THE PU-107/U

a. The gasoline engine generator set PU-107/U (figs 8 and 9) provides a portable source of 400-cycle electrical power for the radar. The internal-combustion, two-stroke,four-cycle engine is of the conventional automotive type. The engine speed governor maintains the engine speed at 1,714 rpm, which is the synchronous speed for 400-cycle operation. The dc system develops 2.5 kw at 28 volts for charging batteries. The alternator is of the rotating permanent-magnet-field type with 28 poles, resulting in a frequency of 400 cycles per second with an engine speed of 1,714 rpm. The alternator generates 120 or 208 volts, depending on the connection used. The ac output connections may be wye or delta; the



1. Hand crank (A89).
2. Muffler (A38).
3. Radiator drain (H477).
4. Fuel pump (O-99).
5. Manual choke (O-88).
6. Engine speed governor (O-126).
7. Carburetor-to-governor linkage (O-129).
8. Ventilating control valve (O-73).
9. Carburetor (O-108).
10. Engine overspeed safety governor (O-128).
11. Ten-conductor socket (J2).
12. Instrument panel (A65)
13. Control panel.
14. Primer pump (O-89).
15. Manual throttle (O-90).
16. Auxiliary fuel line adapter (A17).
17. Low-oil-pressure cutoff switch (S2).
18. Fuel filter (O-92).
19. Oil pressure transmitter (E8).
20. Oil pump (O-82).
21. Crankcase drain.
22. Automatic choke (L3).

Figure 8. Gasoline engine generator set PU-107/U, right view.



1. D-c output terminals (E16, E17).
2. A-c output terminals (E21 through E24).
3. Remote control terminals (E10 through E12).
4. Fire extinguisher (O-162).
5. Wye-delta change board (TB7).
6. Air cleaner (O-113).
7. Starting motor (B1).
8. Igniter assembly (E6).
9. High-coolant-temperature cutoff switch (S3).
10. Oil filler tube (A5).
11. Oil filter (O-87).
12. Radiator (A39).
13. Fan guard (A41).
14. D-c generator (G1).
15. Battery input terminals (E18, E19).
16. Heat exchanger pan (A61).
17. Heater blower motor (B2).
18. Heater (O-155).
19. Heater shield (A80).
20. Heater fuel control valve (L4).
21. Heater fuel pump (L5).

Figure 9. Gasoline engine generator set PU-107/U, left view

wye-delta change board (fig 9), mounted on the left side of the unit, is used to select the desired output. For the AN/TPS-1G, the delta winding is used. The Δ (delta) symbol must be visible through the window on the change board. The cables are connected from the load to the output terminals marked PHASE -A and PHASE -C.

b. The generator must have the following preoperational checks before starting the engine.

(1) There must be enough fuel for the total time of operation.

(2) The coolant system must be filled to capacity.

(3) The crankcase must be filled with the proper oil.

c. Upon completion of these checks, the engine may be started either manually or electrically. Normally, the engine is started electrically, but it can be cranked by hand.

Section III. STARTING THE PU-107/U

34. ELECTRICALLY

a. A hand choke is provided for cool weather starting, but it must not be used when starting the unit electrically. The controls for starting the unit are located on the instrument and control panel, as shown in figure 10.

b. With the 28-volt dc and 400-cycle circuit breakers set to the OFF position, place the IGNITION switch into the REMOTE START position. Set the solenoid ON-OFF switch to ON. Hold the START-STOP switch in the start position for 10 to 15 seconds or until the energizing of the solenoid can be heard. If the engine fails to start, release the START-STOP switch for a few seconds and repeat the start procedure. If the engine still fails to start, call the generator mechanic.

c. During cold weather, the engine must be allowed to warm up before racing or applying a load to the alternator. To warm the engine properly, the manual THROTTLE must be set to idle. Pull the throttle out and lock it into place until the engine is warmed up. After the warmup period, engine oil pressure will be from 15 to 21 psi.

35. MANUAL STARTING

a. A weak battery makes hand cranking necessary. However, the battery must still supply voltage for the ignition.

b. To start the engine, place the 28-volt dc and 400-cycle circuit breakers in the OFF position and place the IGNITION switch in MANUAL START. Engage the hand crank with the crankshaft. (In cool temperatures, the hand choke at the right front of the radiator must be pulled out.) Crank the engine with a quick upward pull on the hand crank, repeating until it starts. After the engine starts, position the IGNITION switch to REMOTE and hold the START-STOP switch to START for a few seconds. This sets all relays and cutoff switches in the correct operating position. The engine must be allowed to warm up at idle in cold temperatures.

Section IV. APPLYING POWER TO THE AN/TPS-1G

36. PU-107/U METER READINGS (Fig 10)

The engine must be operating smoothly with full throttle, and the coolant temperature indicated should be 170° after the warmup period. The voltmeter should register between 120 and 126 volts; the frequency meter should indicate between 400 and 407 cps. Do not apply load to the unit until the engine has warmed up. With the no-load readings correct, set the power unit 400 CYCLE CIRCUIT BREAKER to ON and recheck the meters. The governor control can be adjusted to correct a low or high frequency and voltage reading, but the governor adjustment cannot compensate for an incorrect voltage when the frequency is correct.

37. AN/TPS-1G METERS

a. On the power supply (fig 11), check the VOLTMETER for a reading of 109 to 121 volts and check the LINE FREQUENCY meter for a reading of 384 to 416 cycles. If necessary, the line voltage can be adjusted by means of variable power transformer TF-238/U.

b. The tuning meter on the front panel of the azimuth and range indicator (fig 12) indicates line voltage when the meter switch is in the 115V AC 400∿position. The tuning meter can be used for checking or adjusting the line voltage provided it has been checked against a line voltage of 115 volts as indicated on the power supply VOLTMETER.

38. STARTING THE AN/TPS-1G

a. Log the reading of the OPERATING HOURS meter on the power supply unit (fig 11).

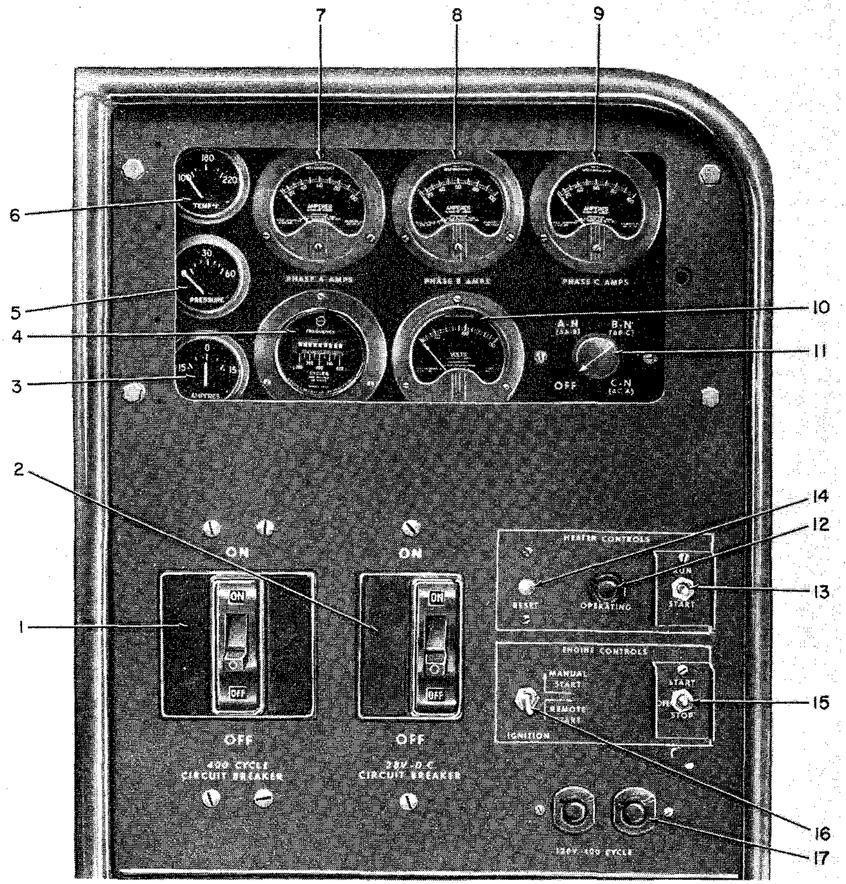
b. The indicator POWER switch should be in the OFF position, the ANTENNA ROTATE control set at zero on the ANTENNA SPEED indicator, the TRIGGER switch (modulator) at EXTERNAL, and the MAGNETRON AGING VARIAC switch at OUT before energizing the radar (figs 12 and 14). The MAGNETRON AGING VARIAC switch (modulator) should be set to the IN position only when the variac is used for magnetron aging; at all other times the switch should be set to the OUT position.

c. Throw the POWER switch (indicator unit) to ON (fig 12). After the switch is set to ON, a 5-minute time delay must elapse before the transmitter and antenna circuits can be energized.

Section V. 5-MINUTE TIME DELAY

39. PURPOSE OF TIME DELAY

The main purpose of the time delay is to warm up the magnetron by filament voltage before the high-voltage pulses are applied to it; this heating time enables all components to become stabilized. In very cold temperatures the 5-minute delay is insufficient, and a longer delay must be used.



1. 400 CYCLE CIRCUIT BREAKER (CB3).
2. 28V.-D.C. CIRCUIT BREAKER (CB1).
3. Battery charging ammeter (M3).
4. Frequency meter (M4).
5. Oil pressure gage (M1).
6. Coolant temperature gage (M2).
7. Ammeter (PHASE A AMPS) (M6).
8. Ammeter (PHASE B AMPS) (M7).
9. Ammeter (PHASE C AMPS) (M8).
10. Voltmeter (M5).
11. Voltmeter selector switch (S8).
12. Heater OPERATING indicator lamp (I-1).
13. Heater RUN—START switch (S7).
14. Heater circuit breaker (RESET) (CB2).
15. START—STOP switch (S4).
16. IGNITION MANUAL START—REMOTE START switch (S1).
17. 120V.-400 CYCLE duplex receptacle (J1).

Figure 10. Instrument and control panel.

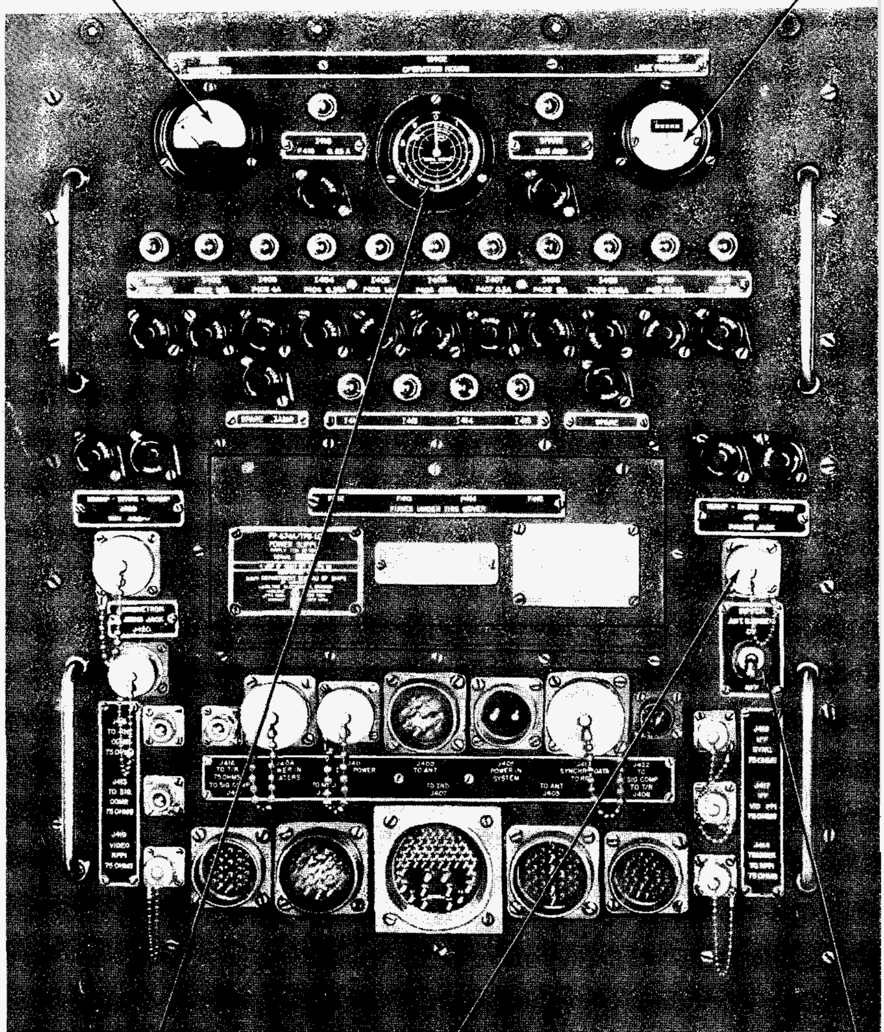


Figure 11. Power supply unit.

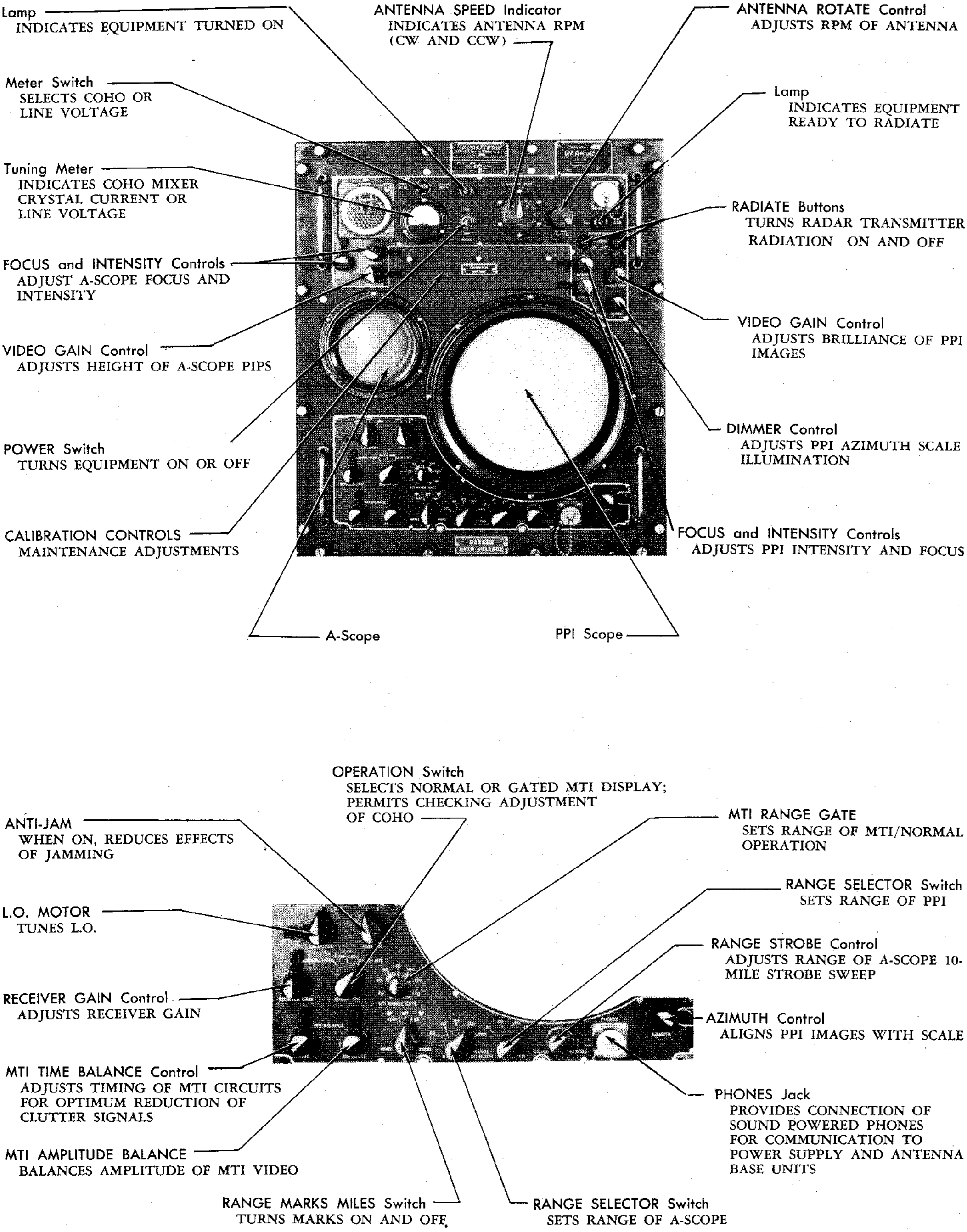


Figure 12. Indicator unit.

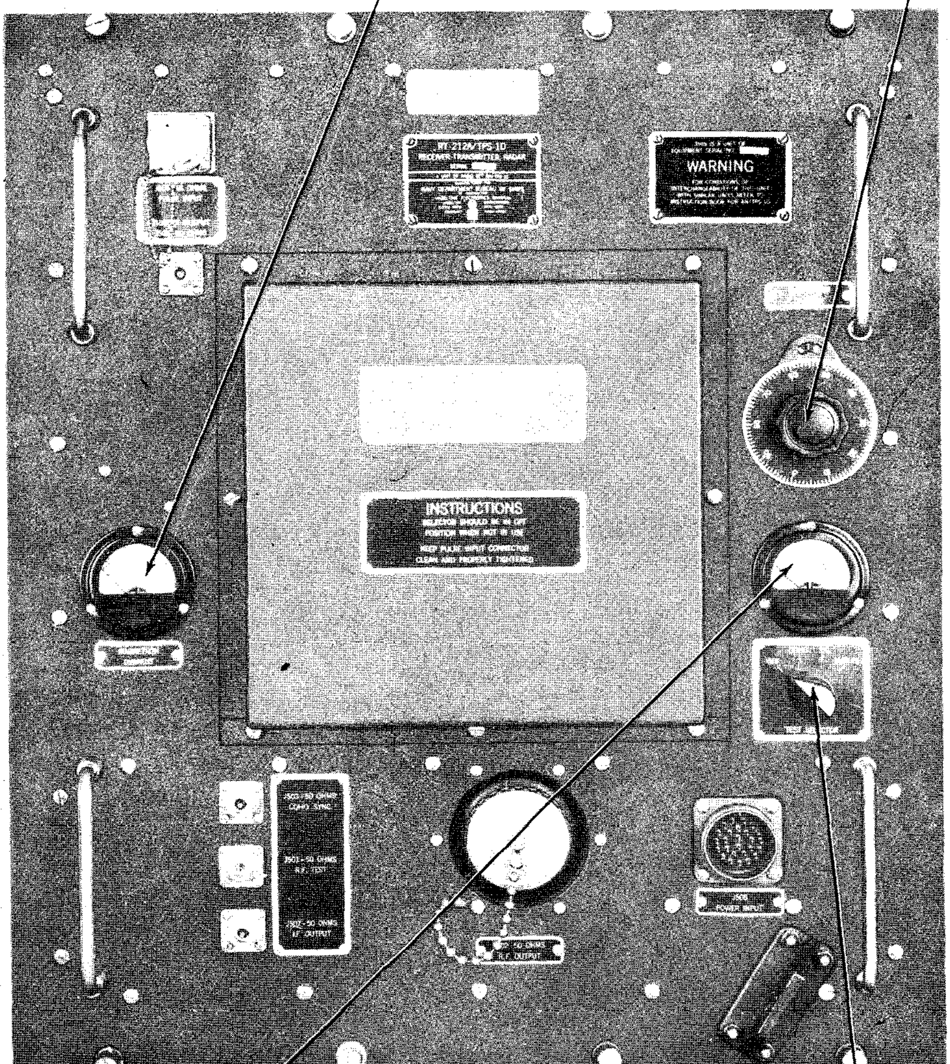
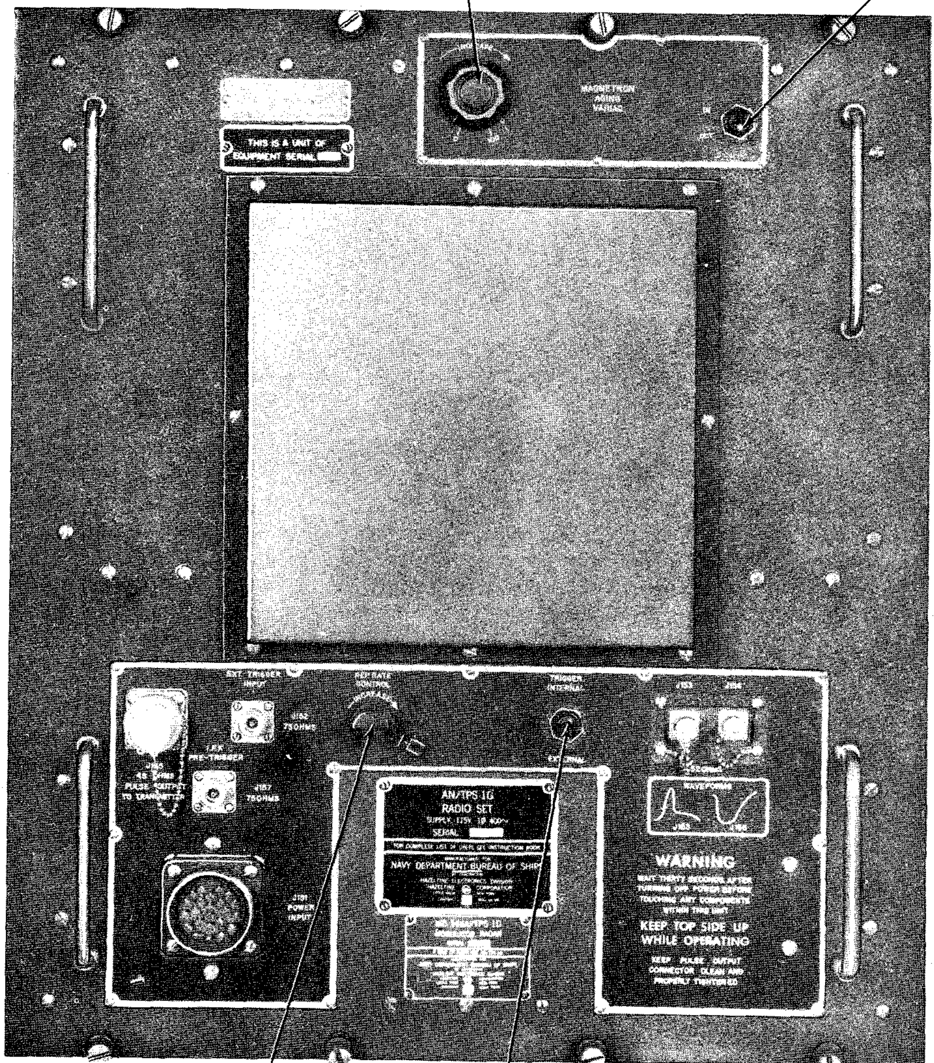


Figure 13. Receiver-transmitter unit.

MAGNETRON AGING VARIAC Control
PERMITS ADJUSTMENT OF MAGNETRON PLATE CURRENT

MAGNETRON AGING VARIAC Switch
SWITCHES VARIAC IN OR OUT OF CIRCUIT



REP. RATE CONTROL
ADJUSTS REPETITION RATE (360-400 PPS), WHEN USING INTERNAL TRIGGERS

TRIGGER Switch
SELECTS EXTERNAL TRIGGERS FOR MTI OPERATION OR INTERNAL TRIGGERS FOR NORMAL OPERATION IN ABSENCE OF MTI TRIGGERS

Figure 14. Modulator unit.

40. CHECKS

a. Observe the blown-fuse indicators (power supply unit) periodically during the next five minutes.

b. The A-scope and the PPI will have spots appearing on their screens (fig 12) when the POWER switch is turned ON. If no spots appear, even when the intensity controls are varied, a possible cause is opened interlocks.

c. At the receiver-transmitter unit monitor the following readings by using the TEST SELECTOR switch in the positions as shown,

POSITION of SWITCH	CORRECT TEST METER READING
MAG FIL	150% RED LINE
COHO	RED LINE
SIG	2/3 RED LINE TO RED LINE

d. Check the TEST METER on the signal comparator for red-line meter readings, when the switches are set in the following positions.

TEST SELECTOR	OPERATION SELECTOR
IF AMP LEVEL	NORMAL
COHO LEVEL	MTI
DELAY LINE INPUT	MTI
NONDELAY OUTPUT	MTI
AMPL BALANCE	MTI

e. The completion of the time delay is indicated by the READY TO RADIATE lamp on the indicator (fig 12).

Section VI. FULL ENERGIZING OF THE RADAR

41. ANTENNA AND TRANSMITTER CIRCUITS

a. The 5-minute time delay must be completed before the transmitter and antenna operational relays and circuits can be energized. With the interlocks in the power supply, receiver-transmitter, indicator, or modulator open, neither the transmitter nor the anten can be operated. When the delay is completed, check the antenna safety switch on the antenna base (fig 15) to make sure that it is on. Set the ANTENNA ROTATE control (indic tor unit) to turn the antenna clockwise, then counterclockwise. Check for smoothness of movement of rotation in both directions.

b. While observing the MAGNETRON CURRENT meter (receiver-transmitter unit), press the RADIATE ON button (indicator unit). Make sure that the magnetron current is steady and in the range of 40-44 ma. Damage to the transmitter magnetron may result if the equipment is operated with a mangetron current greater than 46 ma.

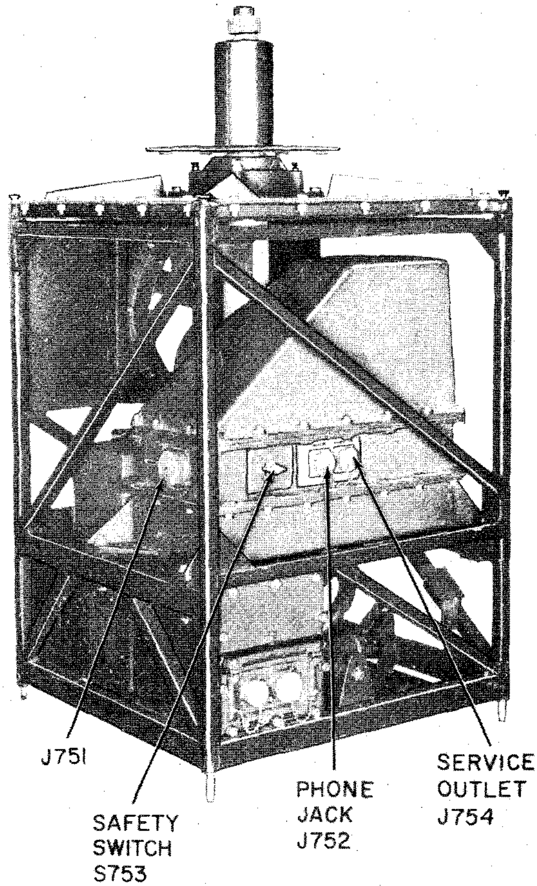


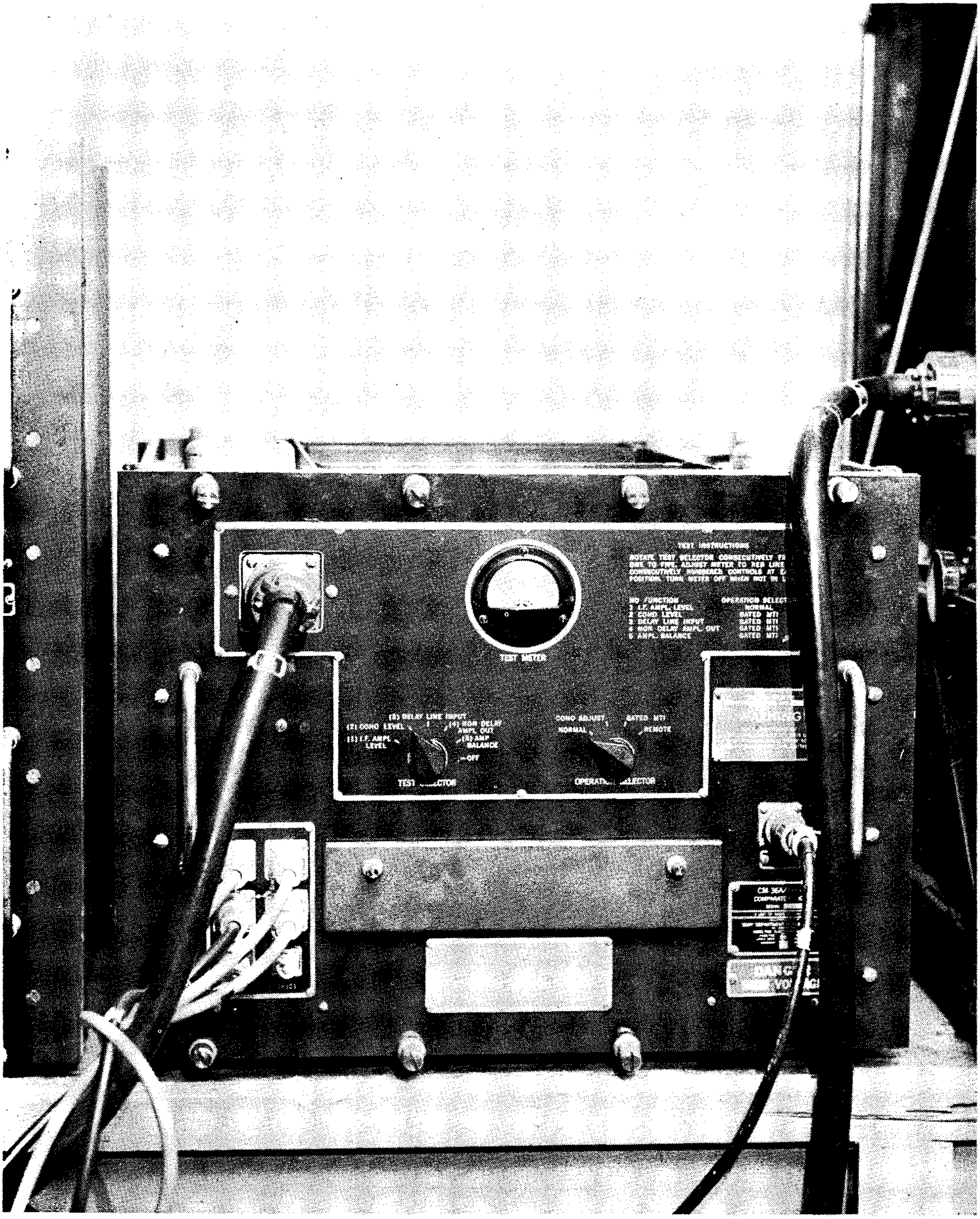
Figure 15. Antenna base AB-498/TPS-1G.

c. On the receiver-transmitter, check the COHO crystal current, SIG (signal) crystal current, and MAG FIL voltage by means of the TEST SELECTOR switch and the red-line reading of the associated meter (fig 13).

42. INDICATOR CONTROL SETTINGS

a. Check the range marks on both the A-scope and PPI screens by turning the RANGE MARKS MILES switch (indicator unit) to TEST and the A-scope and PPI RANGE SELECTOR switches to 80 (fig 12).

b. Check the marks for steadiness and correct number by switching to all ranges on both scopes, with the RANGE MARKS MILES switch in the ON position.


TEST METER
(3) DELAY LINE INPUT
(2) COHO LEVEL
(4) NON DELAY AMPL OUT
(1) I.F. AMPL LEVEL
(5) AMP BALANCE
OFF
COHO ADJUST
GATED MTI
NORMAL
REMOTE

c. Set the following switches as indicated:

OPERATION SELECTOR (signal comparator unit, fig 16) - REMOTE
OPERATION (indicator unit, fig 12) - NORMAL
RANGE SELECTOR (both A-scope and PPI) (indicator units, fig 12) - 160
ANTENNA ROTATE (indicator unit, fig 12) - Zero rpm.

d. Check the adjustment of the A-scope INTENSITY, FOCUS, and VIDEO GAIN controls (located to the left and above the A-scope screen, fig 12) for desired illumination, optimum focus, and a signal height of approximately one inch.

e. Check the adjustment of the PPI INTENSITY, VIDEO GAIN, and FOCUS controls (located to the right and above the PPI screen, fig 12) as follows:

(1) Set the PPI RANGE SELECTOR switch to 80.

(2) Turn the PPI VIDEO GAIN control fully counterclockwise and adjust the INTENSITY control until the trace just disappears.

(3) Advance the VIDEO GAIN control until a trace appears and produces a slightly milky background when the antenna is rotated.

(4) Adjust the FOCUS control for sharpest detail.

f. Check signals on all ranges with the antenna rotating to make sure that the sensitivity of the system is normal.

g. Hold the L.O. MOTOR (fig 12) switch at the INC position until signals drop out.

h. Operate the L. O. MOTOR switch momentarily in the DEC position until signals appear and then operate the L. O. MOTOR switch in either position as required to tune in maximum signals. Be careful not to tune through to the low-frequency side of the transmitter signal frequency.

i. Check the signal comparator (fig 16) for correct meter readings according to the procedure on the signal comparator nameplate. IF AMPL LEVEL control should be adjusted with the RADIATE switch (indicator unit) OFF.

j. Set the OPERATION SELECTOR switch (signal comparator) to REMOTE and set the OPERATION switch (indicator) to GATED MTI.

k. Set the MTI RANGE GATE control (indicator) to a point beyond the ground clutter.

l. With the antenna rotating slowly and using the 20-mile ranges on both screens, adjust the MTI BALANCE (TIME and AMPLITUDE) controls (indicator) individually for a minimum of clutter signals (fixed targets). Make observations at the left end of the A-scope sweep. Clutter signals appear as well-defined steady signals, while moving target signals fluctuate somewhat and are apt to appear as several superimposed signals of slightly varying amplitudes.

m. Set the A-scope RANGE SELECTOR to 160 and the MTI RANGE GATE to 80. Compare the grass level of the MTI video (1st 80 miles) and the normal video (2d 80 miles). If the grass level is different, adjust MTI GAIN control R3306 on the signal comparator for equal noise levels.

n. Set the A-scope RANGE SELECTOR switch at EXP and check the expanded sweep by turning the RANGE STROBE control and observing signals on the A-scope screen.

Section VII. AZIMUTH ORIENTATION OF THE ANTENNA AND PPI SWEEP

43. PURPOSE

The data obtained from radar operation are used at the AADCP and it is imperative that correct information be provided. This is particularly true in respect to azimuth resolution After adjustment, the PPI sweep is constantly oriented with the antenna by synchros in the antenna coupled to PPI sweep rotation.

44. ORIENTATION

The steps of orientation are as follows:

a. Determine the correct azimuth to the most-distant, visible fixed object.

b. Position the antenna until this object appears as a maximum fixed echo on the PPI screen.

c. Turn the AZIMUTH control until the azimuth of the sweep, as indicated on the PPI azimuth scale, is the same as the known azimuth of the fixed object.

Section VIII. DEENERGIZING THE AN/TPS-1G AND THE PU-107/U

45. STOP PROCEDURE

a. Before stopping the set, all malfunctions in operation must be recorded. A record of improper operation aids maintenance men in keeping the set at optimum performance.

b. After noting the malfunctions, the set is stopped in the following manner.

(1) Position and stop the antenna at the desired direction.

(2) Set the RADIATE OFF switch to OFF.

(3) Set the system POWER switch to OFF.

(4) At the PU-107/U, set the 400-CYCLE CIRCUIT BREAKER to OFF.

(5) Hold the START-STOP switch in the STOP position.

(6) Shut off the gasoline supply to the engine.

Section IX. SUMMARY AND QUESTIONS

46. SUMMARY

a. The PU-107/U must provide 115 volts (±5 percent), 400 cycles (±4 percent), single-phase-delta wound, and 7,500 watts of power for the AN/TPS-1G operation.

b. The procedures for starting the PU-107/U and AN/TPS-1G are outlined below.

(1) Start the PU-107/U, either electrically or by cranking.

(2) After checking the power unit voltmeter and frequency meter for correct readings, set the 400-CYCLE CIRCUIT BREAKER to ON.

(3) Set the system POWER switch to ON at the AN/TPS-1G and make necessary checks during the 5-minute warmup period.

(4) After the 5-minute delay, fully energize the transmitter and antenna circuits.

(5) Make all operator adjustments to include the azimuth orientation.

c. The stopping procedure includes, in sequence, the deenergizing of the radar and the power unit.

47. QUESTIONS

a. What are the voltage, frequency, and power requirements of the radar under a load condition?

b. What are the two methods of starting the PU-107/U? Under what condition would each method be used?

c. Name the steps for electrically starting the PU-107/U.

d. Why is there a necessity for a 5-minute time delay?

e. What main circuits cannot be energized before the completion of the time delay?

f. What correct indications must be observed immediately after the system POWER switch is turned on?

g. What is the correct magnetron current reading?

h. Why is the antenna-PPI sweep orientation mandatory?

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